Direct observation of changing NO_x lifetime in North American cities

Joshua Laughner and Ronald C. Cohen
University of California Berkeley

now at: California Institute of Technology

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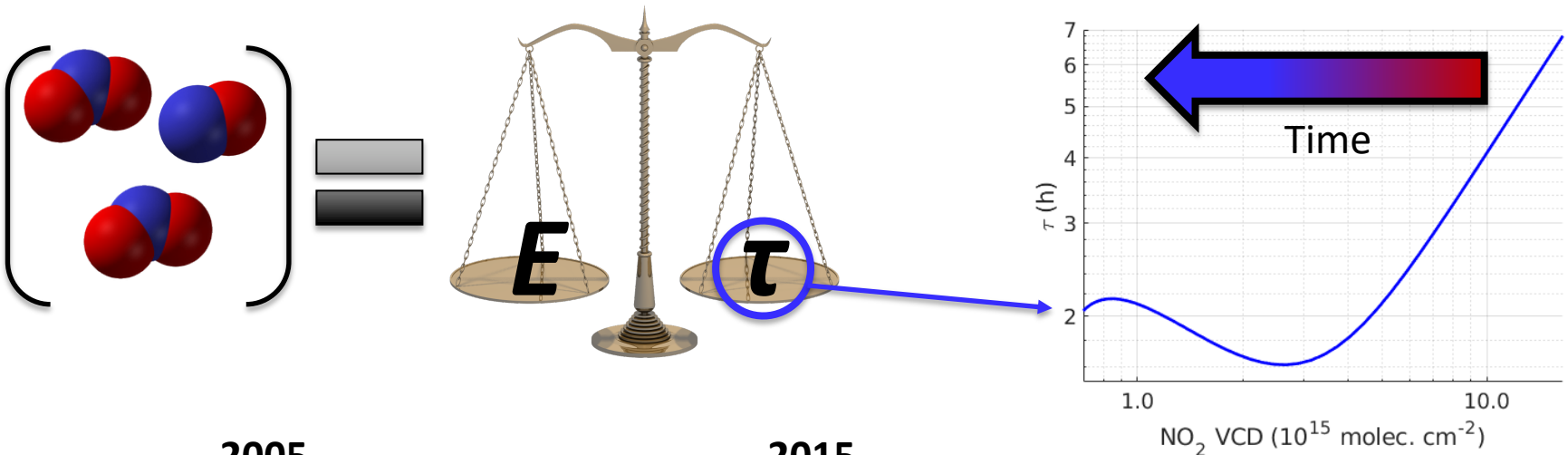
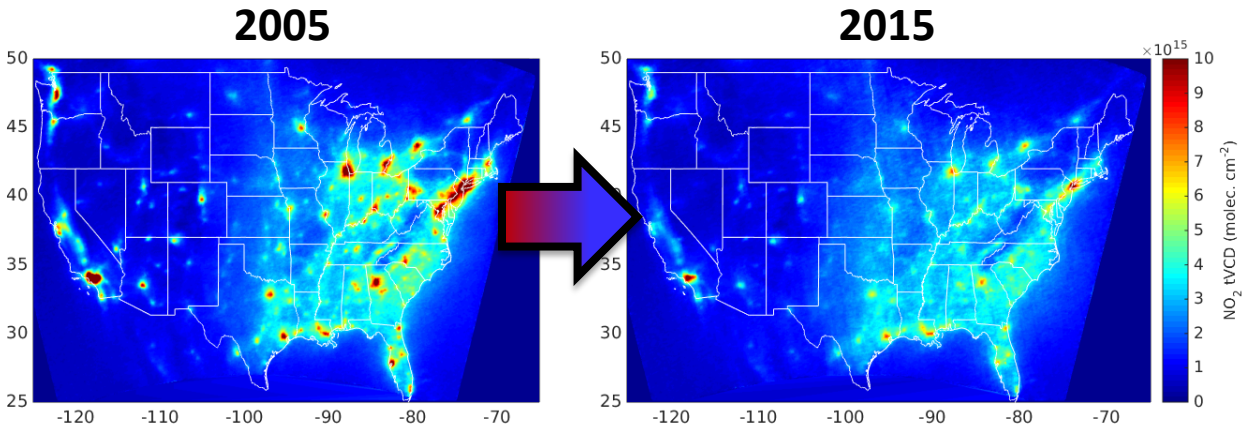
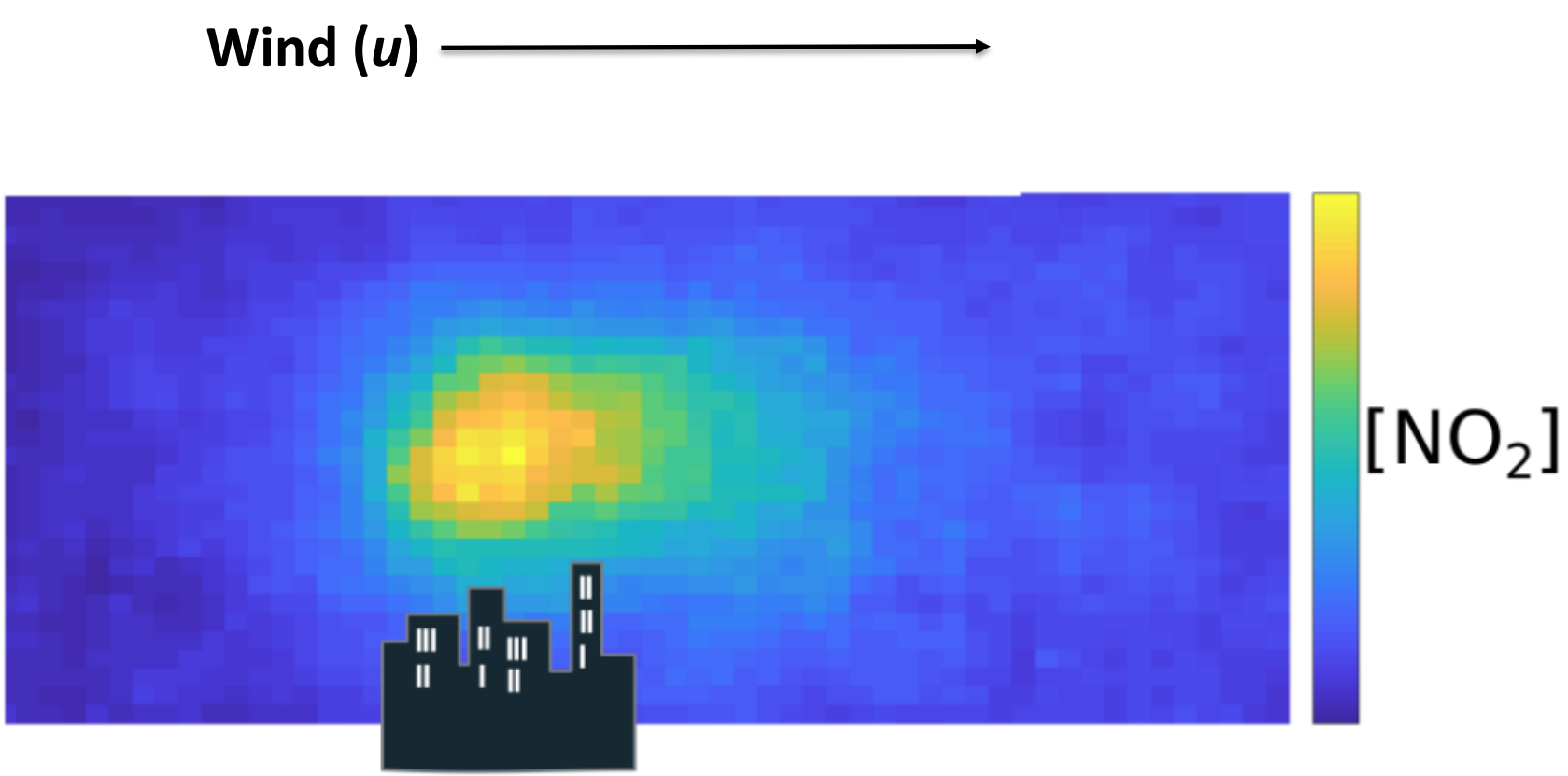
NO_x concentration depends on emissions and lifetime





NO_x lifetime can be observed from space



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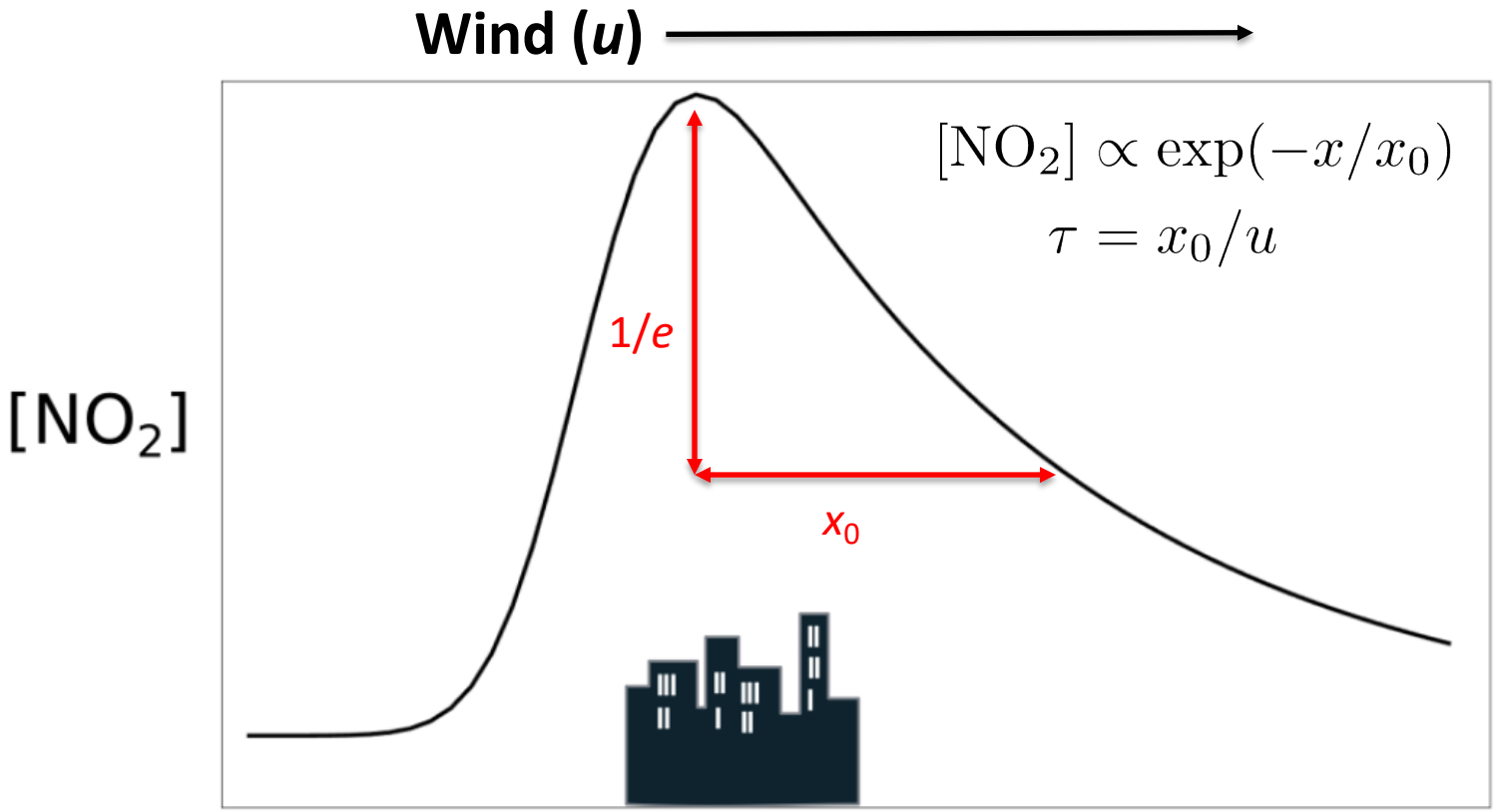
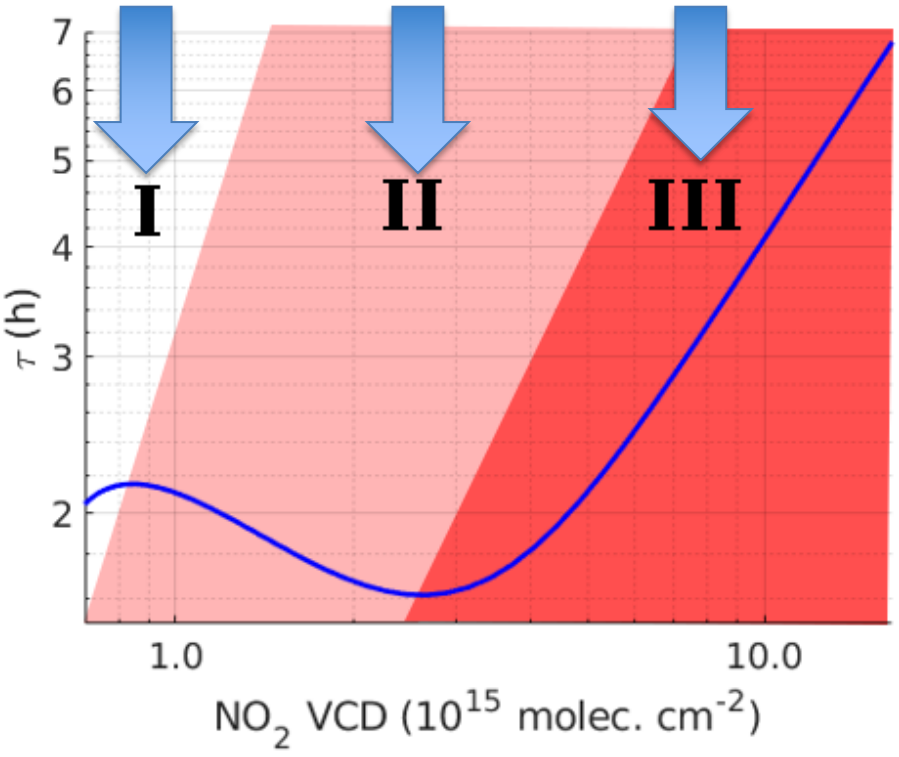
Beirle et al. *Science*, 2011
Valin et al. *GRL*, 2013

NO_x lifetime can be observed from space



Can we relate observed NO_x lifetime to the theoretical model?



- A steady-state model of NO_x lifetime vs. concentration predicts 3 regions with different characteristic slopes:
  I. Very low [NO_x] (< 10^{15} molec. cm^{-2}), positive slope
  II. Low-moderate [NO_x] (1 to ~5×10^{15} molec. cm^{-2}), negative slope
  III. High [NO_x] (> 5×10^{15} molec. cm^{-2}), positive slope
- By observing lifetime in North American cities over 10 years, can we place them on this graph?
- If you want to discuss the effect of VOC reactivity, feel free to discuss with me offline.

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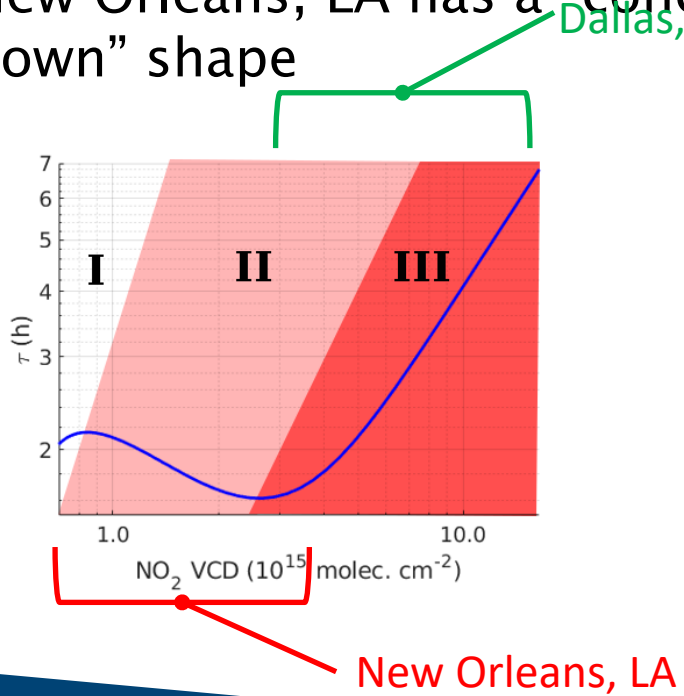
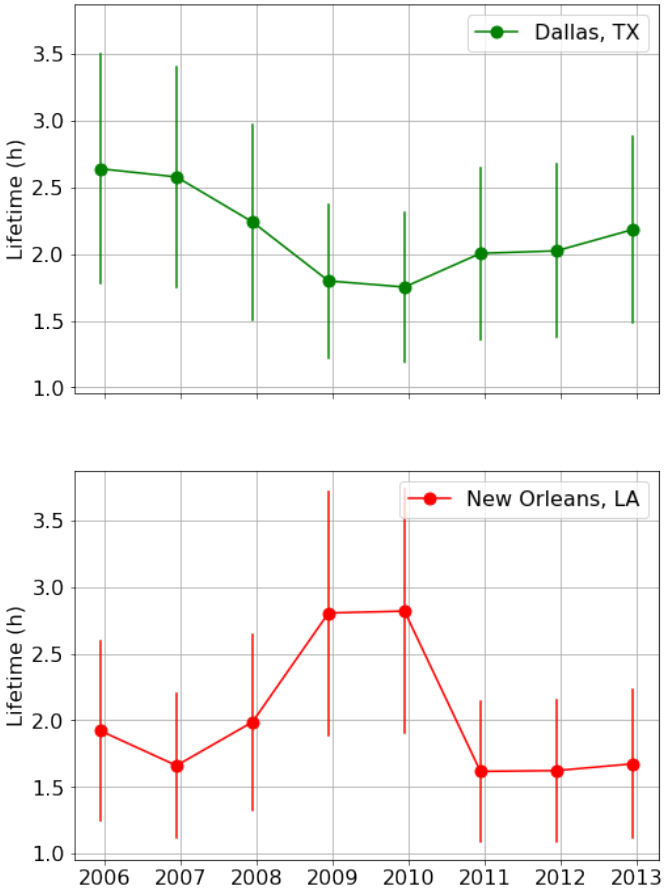
Different North American cities have differently shapes trends in lifetime

- Dallas, TX has a “concave up” shape
- New Orleans, LA has a “concave down” shape





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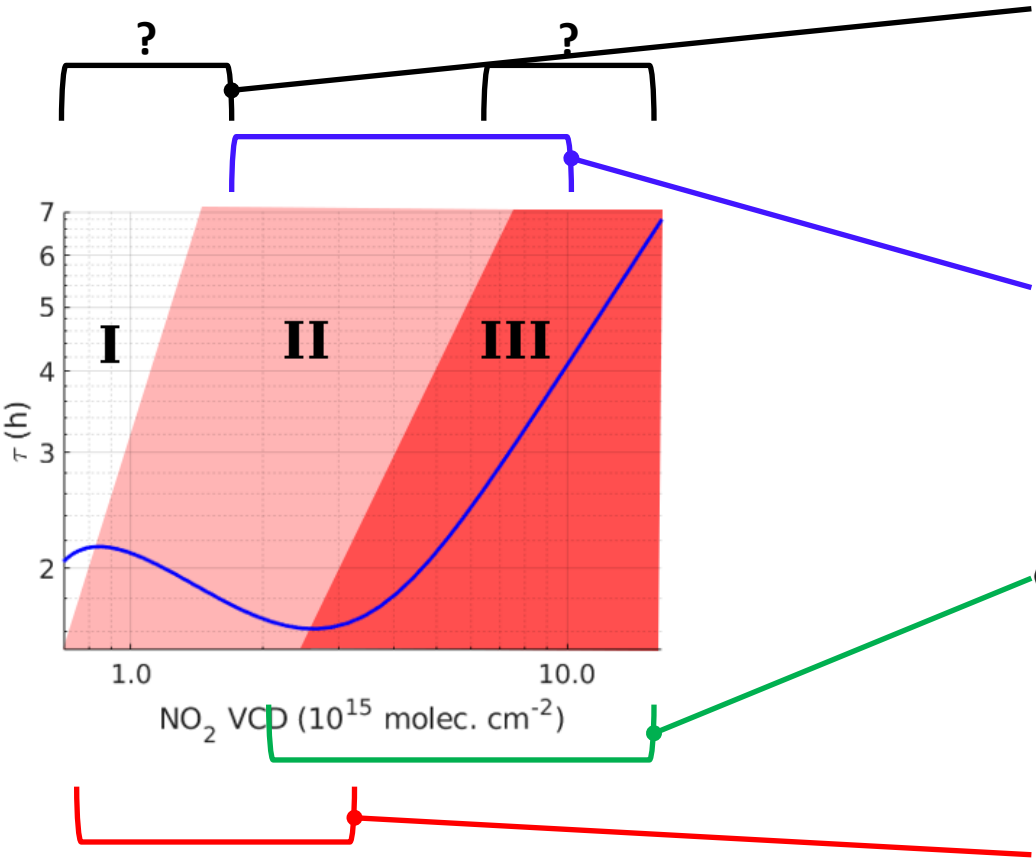

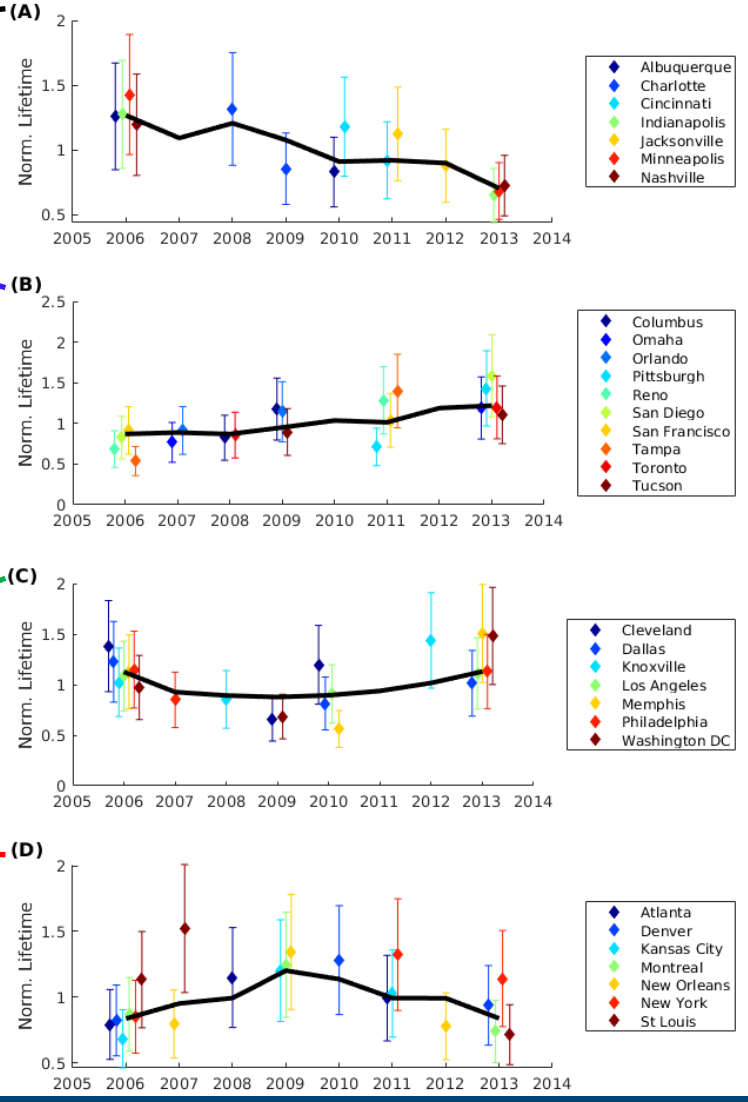

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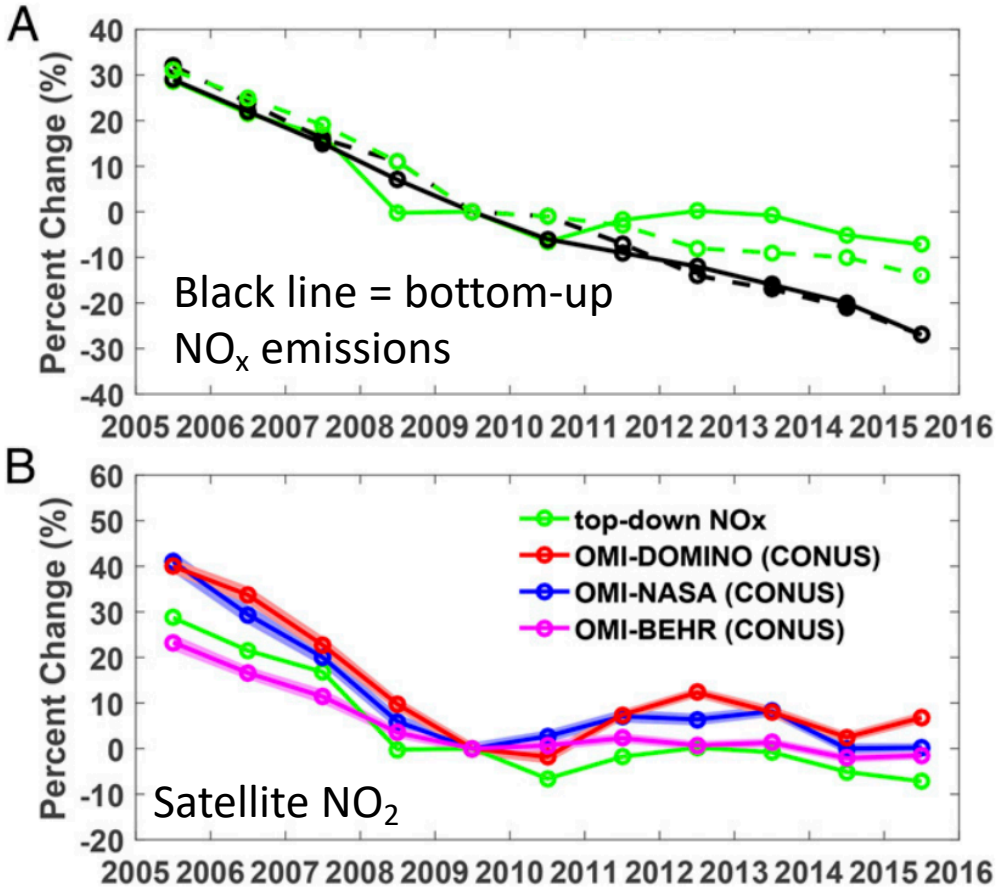
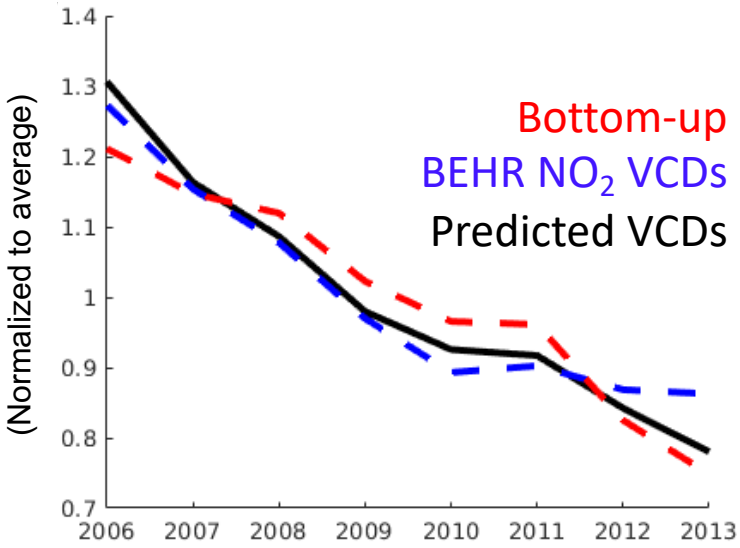
Reconciling trends in bottom-up and top-down emissions

Jiang et al., *PNAS*, 2018



$$[\mathrm{NO_2}] = E\tau$$



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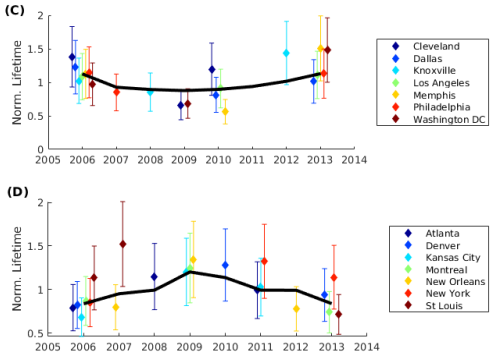
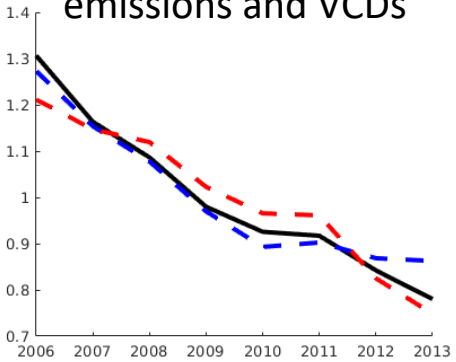
Conclusions

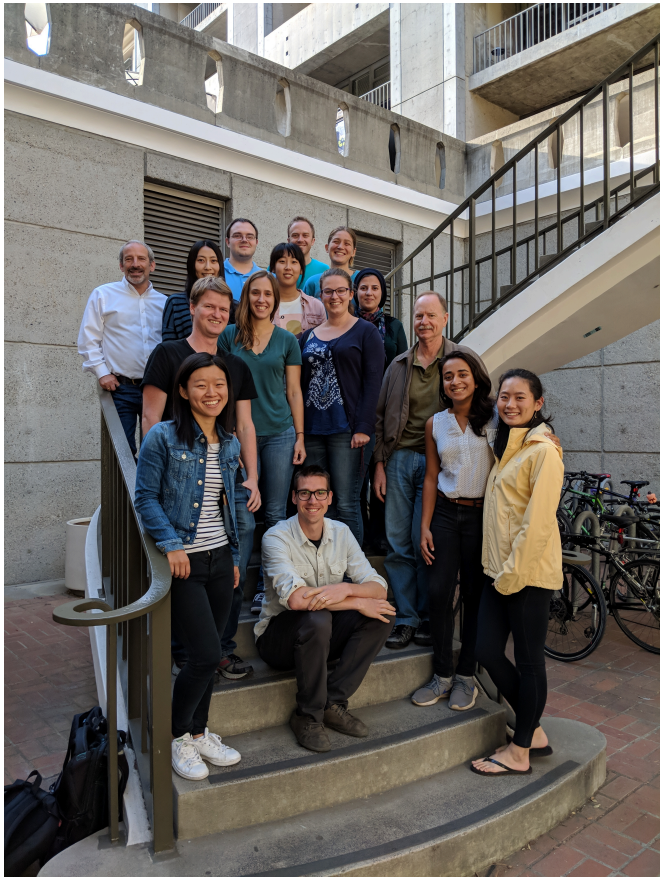
- We observe trends in NO_x lifetime for ~30 N. Am. cities



- Changing lifetime alters the relationship between emissions and VCDs



- Future work will seek to derive trends in OH concentrations



Funding

NASA

Smithsonian Astrophysical Observatory

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